

Taxonomic revision of the genus *Cryptogramma*

R. Br. from China

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Abstract *Cryptogramma* R. Br. from China is taxonomically revised. Two species and one variety are recognized, namely *C. stelleri* (Gmél.) Prantl, *C. brunoniana* Wall. ex Hook. & Grev., and *C. brunoniana* var. *sinensis* (Christ) G. M. Zhang. *C. emeiensis* Ching & K. H. Shing is reduced to synonymy of *C. brunoniana*. The systematic position of this genus is discussed.

Key words *Cryptogramma* R. Br., taxonomic revision, China.

Cryptogramma R. Br., a small fern genus with about 10 species, is mainly distributed in the temperate regions of the Northern Hemisphere and South America. It differs from its related genera in small plants, strongly dimorphic leaves, and tetrahedral-globose spores with verrucate ornamentations.

The systematic position of *Cryptogramma* has long been in dispute. Pichi-Sermolli (1963) put *Cryptogramma*, *Onychium* Kaulf., and *Llavea* Lagasca into Cryptogrammaceae. Ching (1940, 1978) did not accept this family and subsumed these genera into his concept of Sinopteridaceae. This treatment (Ching, 1978) has been followed by some pteridologists (Kung, 1988; Shing, 1990). Tryon and Tryon (1982) included *Cryptogramma*, *Llavea*, and *Onychium* as part of tribe Cheilantheae in a broadly circumscribed family Pteridaceae. In their subsequent taxonomic treatment (Tryon et al., 1990), *Onychium* was transferred into Pteridaceae subfamily Taenitidoideae, whereas *Cryptogramma* and *Llavea* remained in subfamily Cheilanthoideae.

The characteristic verrucate surface without equatorial flange of the spores in *Cryptogramma* differs from that of the spores of most genera of Pteridaceae s. l. The chromosome number of $n = 30$ and general morphology of the plants relate *Cryptogramma* to the cheilanthoid ferns, but its alliances within the group are not clear (Tryon & Lugardon, 1991). From spore morphology, Yu et al. (2001) concluded that *Cryptogramma* is distantly related to the other members of Sinopteridaceae. This is also in agreement with the results from the molecular evidence (R. Cranfill, personal communication). The above phylogenetic analyses indicated that *Cryptogramma*, *Coniogramme* Fée, and *Llavea* are united together and far segregated from both *Onychium* and the cheilanthoid ferns. Compared with the current systems of fern classification, it is reasonable to place *Cryptogramma* in Cryptogrammaceae. However, Pichi-Sermolli's (1963) circumscription of the family should be emended to include *Coniogramme* and to exclude *Onychium*.

Although *Cryptogramma* is a small genus, its taxonomy is still in confusion. Tryon et al.

(1990) merged all species with an erect rhizome into *C. crispa* (L.) R. Br., but this conservative taxonomy was not accepted by most of the pteridologists (Kung, 1988; Alverson, 1989; Shing, 1990). In "Flora Reipublicae Popularis Sinicae" (Shing, 1990), five species were recognized, i.e. *C. stelleri* (Gmél.) Prantl, *C. brunoniana* Wall. ex Hook. & Grev., *C. raddeana* Fomin, *C. emeiensis* Ching & K. H. Shing and *C. shensiensis* Ching. Kung (1988) did not accept the latter two species, and treated *C. shensiensis* as a synonym of *C. brunoniana*, while *C. emeiensis* as a synonym of *C. crispa* (L.) R. Br. var. *sinensis* Christ. Obviously, the taxonomy of *Cryptogramma* is still in question and should be revised.

1 Characters used in this study

1.1 Rhizome

There are two different kinds of rhizome in this genus. *C. stelleri* is distinctive in having a creeping rhizome, while all the other species have an erect one.

1.2 Hydathodes

In some species such as *C. acrostichoides* R. Br. and *C. brunoniana*, hydathodes are present at the end of veins, while in some others such as *C. stelleri* and *C. crispa*, hydathodes are often poorly developed or absent. The size and shape of hydathodes vary frequently, sometimes even in different laminae of the same plant, so it should be combined with other characters in taxonomy.

1.3 Sterile laminae

Compared with fertile laminae, the shape, texture and division of sterile laminae are distinguishable among different species, and have taxonomic value. For example, laminae of *C. stelleri* and *C. crispa* are herbaceous to membsanous, thin, with visible veins; while *C. acrostichoides* and *C. brunoniana* have papyraceous or somewhat leathery laminae. For another example, sterile laminae of *C. stelleri* are 2-pinnate; ultimate segments are nearly round, ovate or fan-shaped, with an entire or shallowly lobed margin; while in *C. brunoniana*, sterile laminae are 3–4-pinnate, with small, ovate ultimate segments.

1.4 Spore morphology

Samples of spores were taken from the specimens that deposited in the Herbarium, Institute of Botany, the Chinese Academy of Sciences (PE). All materials studied were listed in Table 1. The spores were mounted on aluminum stubs using double-sided tape and coated with gold. A model of HITACHI S-800 was used for SEM observation.

Table 1 Origin of materials

Species	Locality	Voucher	Figure
<i>Cryptogramma brunoniana</i> Wall. ex Hook. & Grev.	Jinchuan, Sichuan	C. T. Kuan 825	1–3
<i>C. emeiensis</i> Ching & K. H. Shing	Mt. Emeishan, Sichuan	K. H. Shing & K. Y. Lang 117	4–6
<i>C. shensiensis</i> Ching	Mt. Taibaishan, Shaanxi	C. Huang 2394	7, 8
<i>C. brunoniana</i> var. <i>sinensis</i> (Christ) G. M. Zhang	Salwin-Kiukiang Divide, Yunnan	T. T. Yu 20694	9, 10
<i>C. stelleri</i> Prantl	Bomi, Xizang	T. S. Ying & D. Y. Hong 923	11, 12

The spores of *Cryptogramma* are tetrahedral-globose with verrucate ornamentations. Small papillate elements on the verrucate surface are prominent at high magnification in spores of *C. brunoniana* and its related species (Figs. 1–10), while in *C. stelleri*, the verrucate surface is nearly smooth (Figs. 11, 12).

2 Taxonomic treatments

Cryptogramma R. Br. in Franklin, Narr. Journey Polar Sea, 767. 1823; C. Chr., Ind. Fil. 187. 1906; R. M. Tryon & A. F. Tryon, Ferns All. Pl. 306. 1982; K. H. Shing in Fl. Reip. Pop. Sin. 3 (1): 98. 1990; Tryon et al. in K. U. Kramer & P. S. Green, Fam. Gen. Vas. Pl. I: 246. 1990; E. R. Alverson in Fl. N. Amer. 138. 1993. Type: *C. acrostichoides* R. Br.

Phorolobus Desv. in Mém. Soc. Linn. Paris 6: 291. 1827. Type: *P. crispus* (L.) Desv. = *Cryptogramma crispa* (L.) R. Br.

Allosorus sect. *Homopteris* Rupr. in Dist. Crypt. Vasc. Ross. 48. 1845. Type: *A. stelleri* (Gmél.) Rupr. = *Cryptogramma stelleri* (Gmél.) Prantl.

A genus of about 10 species, mainly distributed in temperate regions, at high altitudes (usually more than 3000 m). Two species and one variety are recognized from China.

Key to the species of *Cryptogramma* from China

1. Rhizomes slender and creeping; leaves spaced distantly; sterile laminae 2-pinnate, herbaceous to membranous, thin; hydathodes absent 1. ***C. stelleri***
1. Rhizomes stout and erect; leaves densely tufted; sterile laminae 3–4-pinnate, papyraceous or somewhat leathery, obscure; hydathodes present and conspicuous 2. ***C. brunoniana***
2. Ultimate segments of sterile laminae triangular, with an acute apex
..... 2a. ***C. brunoniana* var. *brunoniana***
2. Ultimate segments of sterile laminae linear, with a round apex 2b. ***C. brunoniana* var. *sinensis***

1 *Cryptogramma stelleri* (Gmél.) Prantl in Engl. Bot. Jahrb. Syst. 3: 413. 1882; Diels in Engl. u. Prantl, Nat. Pflanzenfam. 1 (4): 280. 1899; C. Chr., Ind. Fil. 187. 1906; Ogata, Ic. Fil. Jap. 2: pl. 63. 1929; Fomin in Busch., Fl. Sibir. et Orient. Extr. 5: 172. 1930; et in Kom., Fl. URSS 1: 78. 1934; Lawalrée in Fl. Europ. 1: 11. 1964; K. H. Shing in Ic. Corm. Sin. 1: 156, fig. 311. 1972; Ching & Y. P. Xu in Fl. Tsinling. 2: 58, pl. 16, figs. 1, 2, 1974; W. C. Shieh in H. L. Li et al., Fl. Taiwan, ed. 1, 1: 286, pl. 100. 1975; et in T. C. Huang, Fl. Taiwan, ed. 2, 1: 213, pl. 88. 1994; Ching et al. in C. Y. Wu, Fl. Xizang. 1: 75. 1983; H. S. Kung in Fl. Sichuan. 6: 285, pl. 92, fig. 2. 1988; K. H. Shing in Fl. Reip. Pop. Sin. 3 (1): 99, pl. 29, figs. 1–4. 1990; K. Iwatsuki, Fern Fern All. Jap. 122, pl. 61, fig. 5. 1992; E. R. Alverson in Fl. N. Amer. 137. 1993. — *Pteris stelleri* Gmél., Nov. Comm. Acad. Petr. 12: 519, pl. 12, fig. 1. 1768. — *Allosorus stelleri* (Gmél.) Rupr., Distrib. Crypt. Vasc. Ross. 47. 1845. — *Pellaea stelleri* (Gmél.) Bak. in Hook. & Bak., Syn. Fil. 453. 1868; Bedd., Handb. Ferns Brit. Ind. 100. 1883.

This species is distinctive in the genus by having a slender, creeping rhizome. It is widely distributed in temperate regions of the Northern Hemisphere, southward to Himalayas, usually at high elevations (1800–4900 m).

Specimens examined:

China. Gansu (甘肃): Mt. Yuelongshan (岳隆山), Z. D. Zhuo (卓正大) 58, 91, 98 (PE); Zhangye (张掖), P. C. Tsoong (钟补求) 9087 (PE). **Hebei** (河北): Mt. Xiaowutai-shan (小五台山), J. T. Li (李继侗) 2491 (PE), F. X. Ji (吉福修) C8 (PE), C. W. Wang (王启无) 62053, 61440 (PE); Laiyuan (涞源), K. M. Liou (刘继孟) 2743 (PE). **Qinghai** (青海): Datong (大通), K. M. Liou (刘继孟) 6905, 6852, 6853, 6894 (PE). **Shaanxi** (陕西): Mt. Taibaishan (太白山), T. N. Liou & P. C. Tsoong (刘慎谔, 钟补求) 2946 (PE). **Sichuan** (四川): Daocheng (稻城), Qinghai-Xizang Exped. (青藏队) 5841 (PE, KUN); Muli (木里), Qinghai-Xizang Exped. (青藏队) 14326, 13788 (PE, KUN), 13873 (PE). **Xinjiang** (新疆): Mt. Tianshan (天山), K. C. Kuan (关克俭) 1744 (PE), R. C. Ching (秦仁昌) 3592 (PE); Mt. Bokelianshan (博克连山), T. N. Liou (刘慎谔) 3595 (PE). **Xizang** (西藏): Cona (错那), C. Y. Wu et al. (吴征镒等) 75-1001 (PE); Zayü (察隅), Qinghai-Xizang Exped. (青藏队) 73-925 (PE), C. W. Wang (王启无) 65735 (PE, KUN), 65793 (PE); Bomi (波密), T. S. Ying & D. Y. Hong (应俊生, 洪德元) 923 (PE), C. Y. Wu et al. (吴征镒等) 4976 (KUN); Lhasa (拉萨), Y. T. Chang & K. Y. Lang (张永田, 郎楷永) 1802 (PE), 1083 (PE); Tingri (定日), C. Y. Wu et al. (吴征镒等) 6059 (KUN). **Yunnan** (云南): Lijiang (丽江), K. M. Feng (冯国楣) 9201 (PE), H. Ohba 332 (KUN), M. Kato 1610, 1665, 1671 (KUN), K. Iwatsuki et al. 1351 (KUN); Eryuan (洱源), NW Yunnan Jin-shajiang Exped. (滇西北金沙江队) 63-6709 (PE, KUN); Zhongdian (中甸), NW Yunnan Jin-shajiang Exped. (滇西北金沙江队) 4511 (PE, KUN), Zhongdian Exped. (中甸队) 1943 (KUN); Dêqên (德钦), T. T. Yu (俞德浚) 9224 (PE); Qinghai-Xizang Exped. (青藏队) 3013 (KUN); Heqing (鹤庆), R. C. Ching (秦仁昌) 24154 (PE, KUN).

America. O. P. Pheips 10 (PE); T. M. C. Taylor 6111 (PE); P. V. Krotkov 6302, 9569 (PE); J. Murdoch s. n. (PE); S. C. Chen et al. (陈心启等) 1379, 1453 (PE).

Canada. S. Brown 712, 1125 (PE).

India. Duthie 1997 (PE).

2 *Cryptogramma brunoniana* Wall. ex Hook. & Grev., Ic. Fil. pl. 158. 1829; C. Presl, Tent. Pterid. 219. 1836; Bedd., Ferns Brit. Ind. 2: pl. 164. 1866; Diels in Engl. u. Prantl, Nat. Pflanzenfam. 1 (4): 280. 1899; C. Chr., Ind. Fil. 187. 1906; W. C. Shieh in H. L. Li et al., Fl. Taiwan, ed. 1, 1: 284. 1975; et in T. C. Huang, Fl. Taiwan, ed. 2, 1: 211. 1994; Ching et al. in C. Y. Wu, Fl. Xizang. 1: 76, pl. 20, fig. 1. 1983; H. S. Kung in Fl. Sichuan. 6: 288, pl. 92, fig. 3. 1988; K. H. Shing in Fl. Reip. Pop. Sin. 3 (1): 102, pl. 29, figs. 12–15. 1990.—*Phorolobus brunonianus* Fée, Gen. Fil. 131, fig. 7D. 1850–1852.—*Cryptogramma crispa* var. *brunoniana* Bak. in Hook. & Bak., Syn. Fil. 144. 1874.—*Cryptogramma crispa* f. *indica* Hook., Sp. Fil. 2: 129. 1858. Type: Himalayas,

Kumaon, Wallich 396 (holotype, K; photo, PE!).

Cryptogramma shensiensis Ching in Fl. Tsinling. 2: 60, pl. 15, figs. 4–6. 1974; K. H. Shing in Fl. Reip. Pop. Sin. 3 (1): 102, pl. 29, figs. 16–19. 1990. Type: China. Shaanxi (陕西): Mt. Taibaishan (太白山), C. Huang 2394 (holotype, PE!).

Cryptogramma emeiensis Ching & K. H. Shing in Acta Phytotax. Sin. 20: 234. 1982; K. H. Shing in Fl. Reip. Pop. Sin. 3 (1): 103. 1990, syn. nov. Type: China. Sichuan (四川): Mt. Emeishan (峨眉山), K. H. Shing & K. Y. Lang 117 (holotype, PE!).

Cryptogramma crispa auct. non R. Br.: C. B. Clarke in Trans. Linn. Soc. 2 (1): 459. 1880; Bedd., Handb. Ferns Brit. Ind. 98. 1883; K. Iwatsuki, Fern Fern All. Jap. 122, pl. 61, fig. 4. 1992.

Cryptogramma crispa R. Br. var. *sinensis* auct. non Christ; H. S. Kung in Fl. Sichuan. 6: 288. 1988.

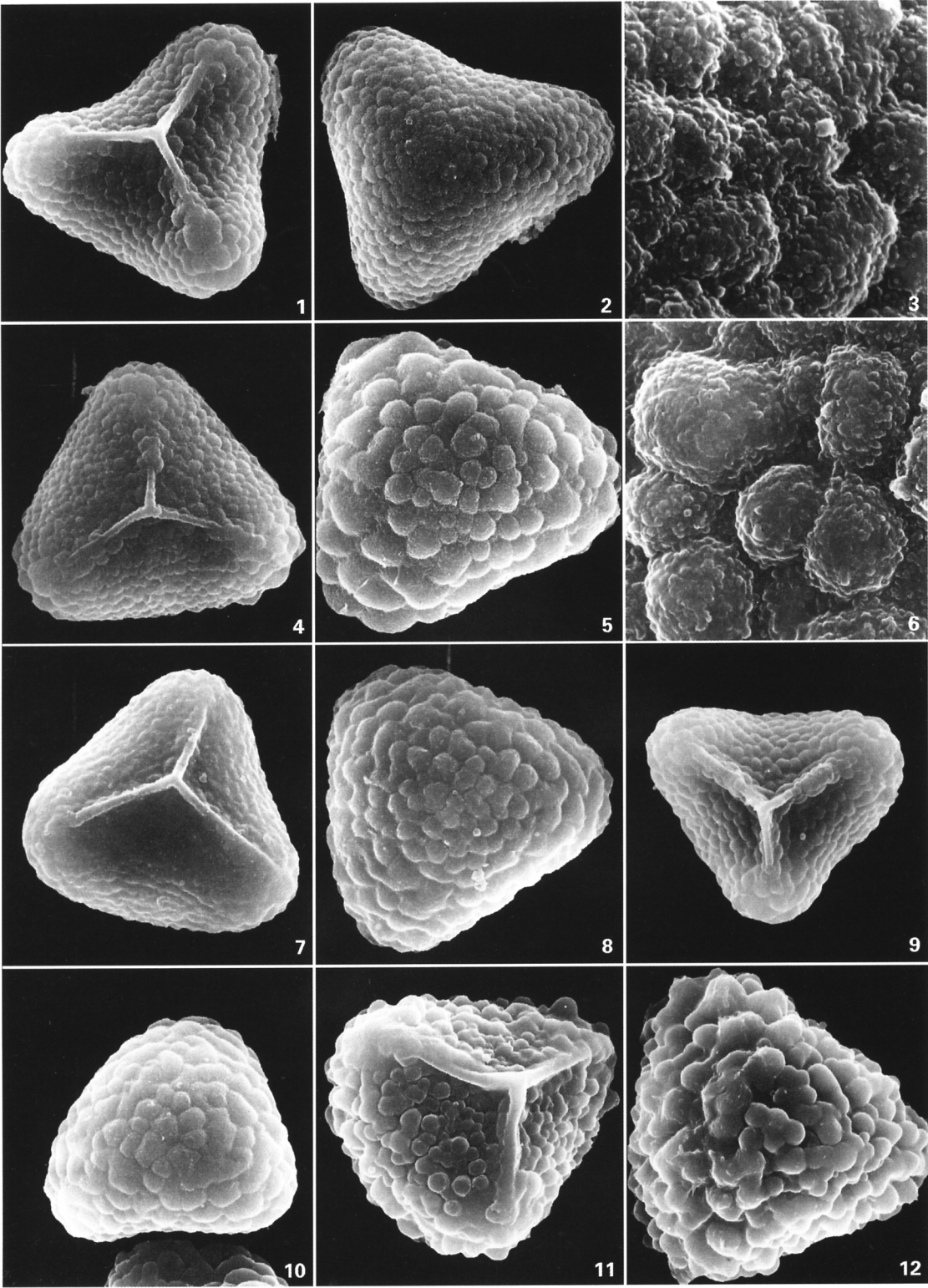
2a. var. *brunoniana*

The species is often confused with *C. crispa* in the past. It differs from the latter in its thick, papyraceous or somewhat leathery sterile laminae with distinctive hydathodes at the end of veins. The type specimen of *C. shensiensis* is only a small plant of *C. brunoniana*, and we accept Kung's treatment (Kung, 1988). *C. emeiensis* is also merely a peculiar form of *C. brunoniana*, which may have resulted from shady habitat. In addition, the spores of *C. shensiensis* and *C. emeiensis* are identical with those of *C. brunoniana* (Figs. 1–8), supporting our taxonomic treatment.

Widely distributed in Himalayan region, northeast to Japan, usually at altitudes of 2200–4700 m.

Specimens examined:

China. Shaanxi (陕西): Mt. Taibaishan (太白山), Y. T. Hsieh (谢寅堂) 2697 (PE); Hu Xian (户县), Giraldo s. n. (PE). **Sichuan** (四川): Jinchuan (金川), C. T. Kuan (管中天) 825 (PE), The Eighth Forest Manag. Exped. (林业部第八森林经理大队) 3772 (PE); Barkam (马尔康), C. L. Wu (吴中伦) 32330 (PE); Baiyu (白玉), L. J. Zhou (周立江) 59-66 (PYU); Xiangcheng (乡城), Qinghai-Xizang Exped. (青藏队) 5082 (PE); without exact location, Qinghai-Xizang Exped. (青藏队) 83-13270 (PE). **Taiwan** (台湾): Mt. Taiha, S. Suzuki s. n. (PE). **Xizang** (西藏): Zayü (察隅), Qinghai-Xizang Exped. (青藏队) 73-530, 73-493 (PE, KUN); Nyalam (聂拉木), Y. T. Chang & K. Y. Lang (张永田, 郎楷永) 3962, 4225 (PE), Xizang Med. Pl. Exped. (西藏中草药普查队) 1519 (PE); Bomi (波密), T. S. Ying & D. Y. Hong (应俊生, 洪德元) 650916 (PE); Tanmyen Chu, F. Ludlow et al. 4619a (PE); Cona (错那), C. Y. Wu et al. (吴征镒等) 75-1001 (PE, KUN); Nyingchi (林芝), Qinghai-Xizang Exped. (青藏队) 751137 (PE); Gongbo'gyamda (工布江达), Qinghai-Xizang Exped. (青藏队) 7627 (PE, KUN); Mêdog (墨脱), B. S. Li & S. Z. Cheng (李勃生, 程树志) 1217 (PE); Mainling (米林), B. S. Li & S. Z. Cheng (李勃生, 程树志) 5828, 5915 (PE). **Yunnan** (云南): Without exact location, Hengduanshan Exped. (横断山考察队) 3622,



3682 (PE); Zhongdian (中甸), Zhongdian Exped. (中甸队) 1942 (PE), W. M. Chu et al. (朱维明等) 20543 (PYU); Qiaojia (巧家), W. M. Chu et al. (朱维明等) 5420 (PYU); Lijiang (丽江), W. M. Chu & Y. M. Feng (朱维明, 冯永明) 766 (PYU); Dêqên (德钦), K. M. Feng (冯国楣) 5167 (PE, KUN), Qinghai-Xizang Exped. (青藏队) 11270 (KUN), J. S. Yang (杨竞生) 8528 (KUN); Yangbi (漾濞), NW Yunnan Jinshajiang Exped. (滇西北金沙江队) 4348 (PE, KUN).

Nepal. H. Tabata et al. 11411 (PE); H. Ohba et al. 8331839, 8580246, 8580579, 8581230 (KUN); H. Hara et al. 2244 (KUN).

2b. var. *sinensis* (Christ) G. M. Zhang, com. nov. — *Cryptogramma crispa* R. Br. var. *sinensis* Christ in Bull. Acad. Géogr. Bot. 15 (3): 135. 1906. Type: West China. E. H. Wilson 5348 (holotype, P!).

Cryptogramma raddeana Fomin in Bull. Jard. Bot. Kieff 10: 3. 1929; et in Bush, Fl. Sibir. et Orient. Extr. 5: 169. 1930; et in Kom., Fl. URSS 1: 78. 1934; C. Chr., Ind. Fil. Suppl. 3: 57. 1934; H. K. Shing in Ic. Corn. Sin. 1: 156, fig. 312. 1972; Ching & Y. P. Xu in Fl. Tsingling. 2: 60, pl. 15, figs. 1–3. 1974; Ching et al. in C. Y. Wu, Fl. Xizang. 1: 75, pl. 20, figs. 2–4. 1983; H. S. Kung in Fl. Sichuan. 6: 286, pl. 92, fig. 1. 1988; K. H. Shing in Fl. Reip. Pop. Sin. 3 (1): 100, pl. 29, figs. 5–11. 1990. — *Allosorus raddeana* (Fomin) Ching in Sunyatsenia 5: 225. 1940, syn. nov. Type: China. Hubei (湖北), A. Henry 6948 (K).

This variety differs from var. *brunoniana* in its linear ultimate segments with a round apex, but this character is not constant and has transitional forms. Moreover, the distribution of these two varieties is largely overlapping in SW China. Based on the above facts, it is reasonable to treat *C. raddeana* as a variety of *C. brunoniana*.

The type specimen of *C. crispa* var. *sinensis* Christ is different from *C. emeiensis* but identical with *C. raddeana*. As discussed above, this variety should belong to *C. brunoniana* instead of *C. crispa*.

Mainly distributed in SW China, northward to Siberia, at altitudes of 2700–4600 m.

Specimens examined:

China. Hubei (湖北): Silvestri 40 (PE). Sichuan (四川): Kangding (康定), H. Smith 11523 (PE), C. S. Liu (刘振书) 1408 (PE). Xizang (西藏): Bomi (波密), H. S. Kung (孔宪需) 6717 (CDBI), T. S. Ying & D. Y. Hong (应俊生, 洪德元) 651152 (PE), B. S. Li & S. Z. Cheng (李勃生, 程树志) 600 (PE), C. C. Ni et al. (倪志诚等) 1481 (PE); Mêdog (墨脱), B. S. Li & S. Z. Cheng (李勃生, 程树志) 309 (PE), Qinghai-Xizang Exped. (青藏队) 74-3860 (PE, KUN); Yadong (亚东), Qinghai-Xizang Exped. (青藏队) 74-2379

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Figs. 1–12. SEM photographs of spores in *Cryptogramma*. 1–8. *Cryptogramma brunoniana* (4–6. *C. emeiensis*; 7, 8. *C. shensiensis*). 9, 10. *C. brunoniana* var. *sinensis*. 11, 12. *C. stelleri*. 1, 2, 4, 5, 7, 8, 11, 12, ×900; 9, 10, ×1020; 3, 6, ×6000.

(PE, KUN); Zayü (察隅), Qinghai-Xizang Exped. (青藏队) 73-1131 (PE, KUN). **Yunnan** (云南): Dêqên (德钦), W. M. Chu et al. (朱维明等) 23577 (PYU), Meili Exped. (梅里队) 25131 (PYU), K. M. Feng (冯国楣) 5167 (KUN), J. S. Yang (杨竞生) 8777 (KUN); Gongshan (贡山), K. M. Feng (冯国楣) 7766 (PE, KUN); Lijiang (丽江), W. M. Chu & Y. M. Feng (朱维明, 冯永明) 766 (PE); Salwin-Kiukiang Divide, T. T. Yu (俞德浚) 20694 (PE, KUN), 20775 (PE).

Russia. S. Kharkevich et al. s. n. (PE).

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中国珠蕨属的分类修订

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摘要 对国产珠蕨属 *Cryptogramma* R. Br. 的分类进行了修订, 承认 2 种 1 变种, 即稀叶珠蕨 *C. stelleri* (Gmél.) Prantl, 高山珠蕨 *C. brunoniana* Wall. ex Hook. & Grev. 和珠蕨 *C. brunoniana* var. *sinensis* (Christ) G. M. Zhang。将峨眉珠蕨 *C. emeiensis* Ching & K. H. Shing 并入高山珠蕨。同时对该属的系统位置进行了讨论。

关键词 珠蕨属; 分类修订; 中国